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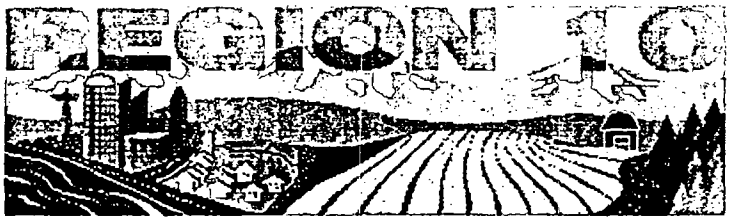

Appendix to Ecology Milestones for Head of Hylebos Waterway

Technical Memorandum

Analysis of the Potential for Upland Groundwater to Contaminate Sediments in the Head of Hylebos Waterway

August 1999

URS Greiner
in association with
CH2M HILL
White Shield, Inc.

APPENDIX TO ECOLOGY MILESTONES FOR HEAD OF HYLEBOS WATERWAY

TECHNICAL MEMORANDUM

ANALYSIS OF THE POTENTIAL FOR UPLAND GROUNDWATER TO CONTAMINATE SEDIMENTS IN THE HEAD OF HYLEBOS WATERWAY

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TABLE OF CONTENTS

LIST OF TABLES

APPENDIX TO ECOLOGY MILESTONES FOR HEAD OF HYLEBOS WATERWAY

TECHNICAL MEMORANDUM

ANALYSIS OF THE POTENTIAL FOR UPLAND GROUNDWATER TO CONTAMINATE SEDIMENTS IN THE HEAD OF HYLEBOS WATERWAY

1. INTRODUCTION

As part of the source control investigations for the Commencement Bay Nearshore/Tideflats Superfund site, the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) identified potential or confirmed sources of problem chemicals to each of the waterways. Problem chemicals had been previously identified during the remedial investigation of sediments. Fifteen facilities were identified by Ecology as actually or potentially having released contaminants to the head of the Hylebos Waterway (defined as the waterway southward of Lincoln Avenue). Pathways for releases from these upland facilities included direct discharges, spills, improper disposal or landfilling of waste materials, discharge of contaminated groundwater, surface waterway runoff, and erosion of contaminated soils. Remediation of the contaminated media at these upland facilities is ongoing and most of the cleanup actions are complete. This technical memorandum evaluates the potential for low levels of contaminants remaining in groundwater after the upland facility cleanup to recontaminate sediments following waterway remediation and is intended to serve as an appendix to Ecology's Milestone reports for the head of the Hylebos Waterway. The potential for stormwater discharges to impact sediment quality is addressed in a separate memorandum.

The groundwater analysis relies upon groundwater quality data collected by or reported to Ecology to determine the potential impact to sediment quality. Further information about cleanup activities at these facilities and groundwater monitoring data is provided in Ecology's Milestone 3 and 4 reports for the Head of the Hylebos Waterway. Only those data representative of post-cleanup groundwater that could discharge to the waterway were used (i.e., no pre-cleanup or upgradient groundwater data were used).

2. APPROACH

Groundwater from facilities surrounding the Hylebos Waterway discharges into the waterway. Before groundwater discharges, it passes through waterway sediment. While the groundwater is in contact with the sediments, a portion of the contaminants dissolved in groundwater is retained on the sediment particles. The amount of contaminants retained in the sediment is a function of a variety of chemical and sediment-specific factors, groundwater concentration, and duration of the discharge.

A multi-step screening approach was used to evaluate the potential of groundwater discharges to the Hylebos Waterway to recontaminate sediment. The screening process began with a review of the data and excluding from further analysis any sites with no groundwater monitoring data.

Data collected prior to cleanup activities and data from upgradient wells were also excluded from further analysis. Potential sediment concentrations were calculated based on groundwater concentrations and conservative assumptions (discussed later in this memorandum). The estimated sediment concentrations were compared to sediment quality objectives (SQOs) specified in the Commencement Bay Record of Decision (ROD) (EPA 1989) to determine source control effectiveness. If the calculated sediment concentrations exceeded the SQOs, there is a potential for groundwater to impact Hylebos sediment quality.

Step 1: Data Compilation

Existing environmental sampling data from the 15 upland sites were compiled by Ecology. A summary of environmental conditions, remedial activities, and sampling results from these sites is provided in the draft Milestone 3 and 4 reports (Ecology 1998a,b). Site-specific reports are listed in Section 5 (References). The files for sites listed below were reviewed to locate groundwater and seep data.

- Kaiser Aluminum and Chemical Company (3400 Taylor Way)
- Elf Atochem (3009 Taylor Way)
- Elf Atochem (2901 Taylor Way)
- General Metals (1902 Marine Way Drive)
- Wasser Winters Log Sort Yard (1602 Marine View Drive)
- Louisiana-Pacific (3701 Taylor Way)
- Blair Backup Property (2902 Taylor Way)
- Tacoma Boatbuilding Company, Yard #1 (1840 Marine View Drive)
- Modutech Marine (2218 Marine View Drive)
- Jones-Goodell (1690 Marine View Drive)
- Hylebos Marina (1940 Marine View Drive)
- Nordlund Boat (1622 Marine View Drive)
- USG Interiors (2301 Taylor Way)
- Murray Pacific Log Sort Yard (3502 Lincoln Avenue)
- Don Oline Marine View Drive (2120 Marine View Drive)

Step 2: Identification of Applicable Groundwater Data

The existing data were reviewed to determine if groundwater data were available for the site. Groundwater data include data collected from monitoring wells and data from seeps that discharge from the banks of the waterway. Seep data were also used to represent groundwater quality at the point of discharge, for the purpose of the evaluation. The applicable groundwater data used for this evaluation are provided in Appendix A.

No post-cleanup groundwater or seep data was available from the following sites:

- Modutech Marine
- Hylebos Marina
- Nordlund Boat

- Kaiser Aluminum
- Tacoma Boatbuilding
- Jones-Goodell
- Don Oline Marine View Drive

For sites with post-cleanup groundwater data, upgradient wells were excluded from review because they are not considered to be representative of the quality of groundwater discharging into the Hylebos Waterway.

Those sites (Table 1) with groundwater data that were not eliminated in this screening step were subjected to additional screening in Step 3, as described below.

Step 3: Derivation of Groundwater Screening Concentrations

In this step, groundwater chemistry monitored at the remaining sites was evaluated to determine the groundwater concentration that could trigger a concern for sediment recontamination. The mass of dissolved groundwater contaminants that could potentially bind with sediment was estimated. The portion of the dissolved groundwater contaminant that is retained on sediment is a function of the partitioning (or distribution) coefficient (K_d) and the groundwater concentration (C_w). The sediment concentration (C_s) is predicted using the following relationship:

$$C_s = C_w * K_d$$

Where:

C_s = sediment concentration (mg/kg)

C_w = groundwater concentration (mg/L)

K_d = partitioning coefficient (L/kg)

By rearranging this equation, the corresponding water concentration for any given sediment contaminant concentration and its associated partitioning coefficient can be calculated.

$$C_w = \frac{C_s}{K_d}$$

The SQOs are the standards by which chemical concentrations in sediment are evaluated to determine if remediation may be needed. By substituting the SQO for a chemical concentration into the above equation, the groundwater concentration that results in a sediment exceedance of its SQO can be calculated. The groundwater concentration for each contaminant that results in an exceedance of its SQO in sediment is referred to as the groundwater screening concentration (GWSC). Groundwater concentrations exceeding the GWSC indicate a potential for sediment recontamination and that existing source control may not be sufficient to protect sediment

quality. Table 2 shows the resulting GWSC calculated for the chemicals identified at the screening Step 3.

The relationship used to calculate the GWSC is a common method for predicting groundwater concentrations from sediment concentrations. The method makes several conservative assumptions. First the method assumes that dissolved chemicals are removed from water by sorption onto the sediment particles. Sorption is mainly controlled by the solubility of a chemical and the total surface area of the sediment particles available for chemicals to adhere.

A related assumption is that sorption can be defined by a simple partitioning coefficient. The partitioning coefficient (K_d) is a measure of the sorption/desorption potential and characterizes the tendency of a chemical to bind to sediment. The higher the K_d, the greater the potential for a chemical to sorb to the sediment matrix. Organic carbon and clay minerals have the highest sorption potential. Thus, the K_d for a chemical will vary with the composition of the sediment (fine-grained sediments have greater sorptive capacity than coarse-grained material). Low K_d values are generally associated with coarse-grained sediments and high K_d values are generally associated with finer-grained sediments.

No site-specific K_d values are available; therefore, a range of K_d values was identified from Strenge and Peterson (1998). For this analysis K_d values are assumed to be directly proportional to the sediment concentration. For the purpose of this evaluation, intermediate K_d values were used (Table 2) because they are appropriate for the type of sediment (i.e., silt and fine sand and low to moderate organic carbon concentrations) present in the Hylebos Waterway and they also offset some of the conservatism of some of the other assumptions used in this screening approach.

The third assumption is that there is a linear relationship between sediment concentrations and groundwater concentrations with an unlimited number of sorption sites in the sediment matrix. For some types of sediment this assumption may not be met due to a limited number of sorption sites. As the sorption sites fill, the amount of chemical that can bind to the sediment reaches a maximum level. In these cases, assuming a linear relationship may significantly overpredict sediment concentrations. Generally, the assumption of linearity is valid for chemicals that are present at concentrations less than half of their solubility (Lyman 1992). Most of the chemical concentrations observed in groundwater in the Hylebos Waterway are at least an order of magnitude less than their corresponding solubility limit. Therefore, the assumption of linearity is reasonable for the purposes of this analysis.

Another assumption is that the processes by which chemicals are transferred from groundwater to the sediment is an instantaneous equilibrium reaction. Sorption is a reversible reaction and assumes that at any given time, some portion of the dissolved chemical is partitioning to the sediment while some portion is also desorbing and dissolving into the water. As dissolved concentrations change, the relative amount of contaminant that is sorbing and desorbing will change. For example, as the dissolved concentrations decrease, the amount of contaminant going back into solution from the sediment will likely increase. The instantaneous sorption reaction assumption implies that sediment concentrations will immediately change in response to corresponding changes in groundwater concentrations. The rates of desorption/sorption are

rarely measured, but in cases where they have been measured, they are generally found to be very slow (i.e., not at equilibrium). If the sorption reaction is time dependent, sorption between groundwater and sediment may never reach equilibrium conditions when groundwater concentrations fluctuate. In environments where the transfer between groundwater and sediments is not in equilibrium, significant errors in estimating sediment loading may occur. The potential error introduced by not accounting for the time dependent nature of the sorption reactions is negligible for the purpose of developing a screening approach for evaluating the sediment recontamination risk from groundwater.

As described above, the method used to calculate the GWSC makes conservative assumptions and is generally biased towards estimating higher sediment concentrations. There are several alternative methods for determining groundwater impacts to sediment; however, these methods either include additional variables for which site-specific data are unavailable or require additional field sampling and laboratory analysis. The approach used in this analysis is a reasonable and conservative way of evaluating source control effectiveness and is useful in identifying sites where groundwater discharges could potentially recontaminate sediments.

For this evaluation, if a groundwater or seep concentration is less than the GWSC, it is predicted that the SQO will not be exceeded in sediment; therefore, the chemical will not likely impact sediment quality in the Hylebos Waterway. If the groundwater or seep concentration is equal to or greater than the GWSC, there is a potential for an exceedance of SQO in sediment. Comparison of the site-specific conditions to the GWSC was conducted in Step 4.

Step 4: Comparison of Site-Specific Groundwater Quality to GWSC

The GWSC were compared to the groundwater and seep quality data to identify sites with exceedances. Since there were multiple sampling events and locations, average concentrations at each site were used to screen against the GWSC. The applicable groundwater data and statistical summary used for this evaluation are provided in Appendix A. The only site with groundwater concentrations exceeding the GWSC was the Elf Atochem 2901 Taylor Way site (Table 1).

3. SOURCES OF UNCERTAINTY

This section further explains some of the uncertainties associated with the findings of this recontamination analysis. Although the analysis is not without uncertainty, it does present a sufficient level of information to support informed risk management decisions. The following is a list of the assumptions made with brief explanations of the resultant uncertainties that may influence the outcome of this analysis.

- This analysis assumes that groundwater flows towards and through sediments prior to discharging into the Hylebos Waterway and that contamination carried in groundwater is not degraded, dispersed or diffused. The approach selected to estimate groundwater recontamination potential does not include variables for degradation, dispersion, diffusion, retardation, and sediment deposition. To not account for these processes is a conservative assumption since they do occur and would reduce loading at the groundwater-sediment interface thus reducing the potential for sediment recontamination via groundwater.

- The sampling and analysis protocols employed at each site accurately represent the scale and distribution of groundwater contamination. The uncertainty associated with this type of assumption cannot be quantified.
- The loading of dissolved groundwater contaminants onto sediment can be represented as a simple linear instantaneous equilibrium sorption reaction. The process by which contamination is retained on the sediment is a function of the partitioning coefficient and the groundwater concentration. In environments were sorption between groundwater and sediments are not in equilibrium, significant errors in estimating sediment loading resulting from groundwater may occur. The assumption that the equilibrium sorption reaction is an instantaneous process is conservative for the purpose of this screening approach.
- Site-specific adsorption/desorption studies were not conducted. This analysis assumes that the literature values for partitioning coefficients are representative of site conditions although they may, in fact, be proved to be more or less conservative than actual conditions at some time in the future.
- Average groundwater concentrations and intermediate partitioning coefficients were used in calculating GWSC. Although the use of average concentrations and intermediate partitioning coefficients is less conservative than using maximum values; maximum values reflect extreme conditions that are not likely representative of typical waterway conditions. The use of average concentrations and partitioning values offsets the effects of other conservative assumptions used in this screening approach.

The inputs used to calculate the GWSC are based on conservative assumptions and so bias the GWSC towards estimating elevated sediment concentrations. Although there are several alternative methods for determining groundwater impacts to sediment, those methods are more complex and include additional variables for which site-specific data were not available and would have required additional sampling and analysis.

The reliability of the sediment recontamination predictions may be reduced in cases where actual conditions differ significantly from the assumptions used to formulate the conceptual model. The selected approach for evaluating groundwater source control effectiveness is reasonable and, because of the aggregate effect of input assumptions tending to favor recontamination potential, it is useful in identifying sites where groundwater discharges could potentially recontaminate sediments.

4. SITE-SPECIFIC ANALYSIS

Site-specific analysis concerning the potential impact of groundwater on Hylebos sediments is provided below.

4.1 Kaiser Aluminum and Chemical Company (3400 Taylor Way)

Stormwater, sediment, and groundwater samples have been collected at the Kaiser Aluminum facility. Pre-cleanup groundwater from the site was only analyzed for polycyclic aromatic

hydrocarbons (PAHs), which were not detected. No post-cleanup groundwater data were required.

4.2 Elf Atochem (3009 Taylor Way)

The property was used as a log sort yard from 1964 until 1986. Cleanup actions were completed in October 1992. The cleanup plan included monitoring of groundwater for arsenic, copper, lead, and zinc. The post-cleanup data and statistical summary from eight monitoring wells are provided in Appendix Table A-1. None of detected groundwater concentrations exceeded the GWSC (Table 1). The chemicals analyzed in groundwater at the site are not considered to be a risk for Hylebos sediment.

4.3 Elf Atochem (2901 Taylor Way)

Chlorine-based chemicals and arsenic-based pesticides were manufactured at the site. Active groundwater remediation has been ongoing at the site since the early 1990s. As part of a Consent Decree with Ecology, a sheet pile barrier wall was installed adjacent to the shoreline to slow the flow of groundwater into the waterway. A groundwater extraction and treatment system was installed to treat arsenic-based chemicals and volatile organic compounds (VOCs). Elf Atochem was required to demonstrate that hydraulic containment has been achieved and that there is no flow of arsenic-contaminated groundwater to the waterway. Elf Atochem has been monitoring groundwater for metals since 1992. Groundwater samples have been analyzed for arsenic, antimony, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium and zinc. The most recent shallow data for which all metals were available (May 1997) were used for this screening analysis (Appendix Table A-2 and A-3). Beryllium, cadmium and silver were not detected in any of the samples; however, the laboratory detection limits were not provided. Average groundwater concentrations of arsenic and mercury exceeded their respective GWSC.

A groundwater extraction system to remove dissolved metals from the groundwater appears to be maintaining a landward gradient, preventing shallow groundwater from discharging to the Hylebos Waterway. Under natural groundwater flow conditions, there would be a high potential for groundwater to impact sediments. As long as active hydraulic control is maintained and contaminated groundwater does not discharge into the Hylebos Waterway, based on the screening analysis and balance of data available, it appears that there is a low potential for groundwater to impact Hylebos sediment quality.

4.4 General Metals (1902 Marine Way Drive)

The General Metals site was used as a yard to sort logs and to recycle ferrous and nonferrous metals. A low-permeability cap was installed at the site in the early 1990s. Semiannual groundwater monitoring has been conducted at the property since 1988 for arsenic, copper, lead, zinc, nickel, PCBs, and pentachlorophenol (PCP). Cleanup at the site was completed in 1996. Sixteen monitoring wells in eight clusters are located on the General Metals property. Eight of those wells (GM-5s/d, GM-9s/d, GM-7s/d, and GM-8s/d) are located downgradient of the facility and adjacent (within 200 feet of the shoreline) to the Hylebos Waterway. Data collected

between March 1996 and September 1998 (Appendix Table A-4) from the eight downgradient wells were used to evaluate potential groundwater impacts to Hylebos sediment quality.

Arsenic, copper, lead, nickel, zinc and PCP were not detected in any of the post-cleanup groundwater samples at concentrations greater than the GWSC (Table 1). Average PCBs groundwater concentration did not exceed the GWSC (Table 1).

Four seep samples were collected from the bank on the General Metals site (Appendix Table A-5). None of the detected concentrations exceeded their respective GWSC criteria.

The chemicals analyzed in groundwater at the site are not considered to be a risk for Hylebos sediment.

4.5 Wasser Winters Log Sort Yard (1602 Marine View Drive)

The site was used as a log sort yard. High levels of arsenic, copper, lead, and zinc were detected in soil and surface water runoff. An impermeable cap was installed on contaminated soils. Cleanup activities were completed in 1993. A groundwater monitoring program has been ongoing at the property since 1987. Bimonthly groundwater samples have collected from four monitoring wells since 1994. The samples were analyzed from arsenic, copper, lead and zinc (Appendix A-6).

Groundwater concentrations of arsenic, copper, lead, and zinc greater than the GWSC were not detected (Table 1). The chemicals analyzed in groundwater at the site are not considered to be a risk for Hylebos sediments.

4.6 Louisiana-Pacific (3701 Taylor Way)

Louisiana-Pacific Corporation currently operates a log sort yard at the site. Metals-contaminated soil and surface water runoff were detected at the site. The log yard was capped with an impermeable barrier. Post-cap quarterly groundwater monitoring of four wells has been conducted at the site since 1994. Thirteen rounds of samples for arsenic, copper, lead, and zinc collected between 1995 and 1998 were analyzed (Appendix Table A-7).

Groundwater concentrations of arsenic, copper, lead, and zinc concentrations exceeding the GWSC were not detected in any of the wells. The chemicals analyzed in groundwater at the site are not considered to be a risk for Hylebos sediments.

4.7 Blair Backup Property (2902 Taylor Way)

The former Cascade Timber Yard #2 and Ohio Ferro-Alloy chromium and ferrosilicate plant occupied portions of the site. A soil cleanup was conducted at the site in 1993 and a post-cleanup groundwater sampling program was implemented. Four monitoring wells are located downgradient of the main site. Twenty-seven groundwater samples collected between 1994 and 1996 for arsenic, copper, lead, nickel, and zinc were analyzed (Appendix Table A-8).

Concentrations of arsenic, copper, lead, nickel, and zinc were detected, but not at concentrations exceeding the GWSC (Table 1). The chemicals analyzed in groundwater at the site are not considered to be a risk for Hylebos sediment.

4.8 Tacoma Boatbuilding Company, Yard #1 (1840 Marine View Drive)

Tacoma Boatbuilding yard operated from 1969 to 1996. Activities at the yard were associated with steel and aluminum shipbuilding and repair. Cleanup activities, including removal of sandblast grit from upland and intertidal areas, were completed in the fall of 1998. No post cleanup groundwater data were required.

4.9 Jones-Goodell (1690 Marine View Drive)

The site was operated as a ship/boatbuilding and repair facility from 1968 until 1995. Cleanup activities were completed in 1997. No post-cleanup groundwater sampling was conducted at the site.

4.10 Modutech Marine (2218 Marine View Drive)

No groundwater sampling has been conducted at the site.

4.11 Hylebos Marina (1940 Marine View Drive)

No groundwater sampling has been conducted at the site.

4.12 Nordlund Boat (1622 Marine View Drive)

No groundwater sampling has been conducted at the site.

4.13 USG Interiors (2301 Taylor Way)

The site is an active rock wool manufacturing plant that has been in operation since 1959. Investigations at the facility have included seep and groundwater sampling. Cleanup activities at the site were conducted in September 1998.

Seeps discharging to the waterway contained elevated concentrations of metals. Based on the historical seep data, groundwater concentrations at the site had high potential to exceed the SQO for arsenic, copper, lead, mercury, and zinc. Soils with high concentrations of metals were located in areas between the bank and the monitoring wells, suggesting a source for high metal concentrations in the seeps. In 1996, 4,410 tons of contaminated soil were removed from the bank and an additional 3,134 tons were removed in 1997.

Four groundwater samples collected in October 1998 were analyzed for antimony, arsenic, chromium, copper, lead, and zinc (Appendix Table A-9). Seep samples were collected from two seeps in 1998 and 1999. Concentrations above the GWSC were not detected (Table 1). The chemicals analyzed in groundwater at the site are not considered to be a risk for Hylebos sediment.

4.14 Murray Pacific Log Sort Yard (3502 Lincoln Avenue)

The site was operated as a log sort yard. Investigations conducted at the Murray Pacific log sort yard #1 included seep and groundwater sampling. Six groundwater wells were installed to monitor groundwater quality at the site. Four rounds of samples were collected in 1997 and 1998. The samples were analyzed for arsenic, copper, lead, and zinc (Appendix Table A-10).

Average concentrations of arsenic, copper, lead, and zinc were not greater than the GWSC criteria (Table 1). The chemicals analyzed in groundwater at the site are not considered to be a risk for Hylebos sediment.

4.15 Dom Oline Marine View Drive (2120 Marine View Drive)

The site was used to store equipment and various materials. Site cleanup activities are ongoing at the site. No post-cleanup data are available.

5. CONCLUSIONS

This study evaluated fifteen sites for the potential for groundwater to impact sediments in the head of the Hylebos Waterway.

The evaluation approach consisted of comparing existing groundwater data to groundwater screening criteria that would be protective of sediment quality based on the ROD SQOs. The GWSC represents the maximum groundwater concentrations that would not result in SQO exceedances in sediments. GWSC were developed from the relationship of the chemical-specific distribution coefficient, groundwater, and sediment concentrations.

Of the fifteen sites considered, eight sites were not evaluated either due to lack of data or the lack of post-cleanup data. For those seven sites with groundwater data, concentrations exceeding the GWSC were identified at only one site: Elf Atochem (2901 Taylor Way).

At the Elf Atochem 2901 Taylor Way site, active hydraulic control limits actual groundwater discharges to the waterway. The ability to continue to prevent impacts to sediment is dependent upon maintaining the current active hydraulic control at the site. Otherwise, groundwater has a high potential to impact sediment quality under natural groundwater flow conditions.

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Nordlund Boat (1622 Marine View Drive)

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TABLES

Table 1—Summary of Groundwater Evaluation

Step 1	Step 2	Step 3		Step 4		
Site Name & Address	Groundwater Data Available?	Statistical Summary: Chemical	Statistical Summary: Average Concen. (µg/L)	GWSC (µg/L)	Exceed GWSC?	Potential to Exceed SQO?
Kaiser Aluminum 3400 Taylor Way	No[3]					
Elf Atochem 3009 Taylor Way	Yes	Arsenic	20	750	No	No[4]
		Copper	33	4937	No	No[4]
		Lead	6	375	No	No[4]
		Zinc	40	2790	No	No[4]
Elf Atochem 2901 Taylor Way	Yes	Arsenic	54000	750	Yes	Low[1]
		Antimony	2630	15000	No	No[4]
		Chromium	70	300	No	No[4]
		Copper	80	4937	No	No[4]
		Lead	120	375	No	No[4]
		Mercury	6.3	0.245	Yes	Low[1]
		Nickel	86	384	No	No[4]
		Zinc	54	2790	No	No[4]
General Metals 1902 Marine Way Dr.	Yes[2]	Arsenic	19	750	No	No[4]
		Copper	3.9	4937	No	No[4]
		Lead	1.55	375	No	No[4]
		Nickel	17	384	No	No[4]
		Zinc	12.5	2790	No	No[4]
		PCBs	0.19	1	No	No[4]
		PCP	3.8	5.3	No	No[4]
		Arsenic-Seep	33	750	No	No[4]
		Copper-Seep	122	4937	No	No[4]
		Zinc-Seep	347	2790	No	No[4]
Wasser Winters 1602 Marine View Dr.	Yes	Arsenic	39	750	No	No[4]
		Copper	2.4	4937	No	No[4]
		Lead	2	375	No	No[4]
		Zinc	15	2790	No	No[4]
Louisiana-Pacific 3701 Taylor Way	Yes	Arsenic	20	750	No	No[4]
		Copper	5.5	4937	No	No[4]
		Lead	6.7	375	No	No[4]
		Zinc	18	2790	No	No[4]
Blair Backup Property 2902 Taylor Way	Yes[2]	Arsenic	118	750	No	No[4]
		Copper	13	4937	No	No[4]
		Lead	6.4	375	No	No[4]
		Nickel	10	384	No	No[4]
		Zinc	10	2790	No	No[4]
Tacoma Boatbuilding 1840 Marine View Dr.	No[3]					
Jones-Goodell 1690 Marine View Dr.	No[3]					
Modutech Marine 2218 Marine View Dr.	No[3]					

Table 1—Summary of Groundwater Evaluation

Step 1	Step 2	Step 3		Step 4		
		Statistical Summary				
Site Name & Address	Groundwater Data Available?	Chemical	Average Concen. (µg/L)	GWSC (µg/L)	Exceed GWSC?	Potential to Exceed SQO?
Hylebos Marina 1940 Marine View Dr.	No[3]					
Nordlund Boat 1622 Marine View Dr.	No[3]					
USG Interiors 2301 Taylor Way	Yes	Antimony	100	15000	No	No[4]
		Arsenic	30	750	No	No[4]
		Chromium	22	300	No	No[4]
		Copper	20	4937	No	No[4]
		Lead	5	375	No	No[4]
		Zinc	30	2790	No	No[4]
Murray Pacific 3502 Lincoln Ave.	Yes	Arsenic	171	750	No	No[4]
		Copper	15	4937	No	No[4]
		Lead	15	375	No	No[4]
		Zinc	34	2790	No	No[4]
Don Oline Marine View 2120 Marine View Dr.	No[3]					

Notes:

Steps 1 through 4: Screening steps used in analysis described in text.

[1] Existing average concentrations exceeded screening criteria. Site undergoing remediation and hydraulic control minimizes shallow groundwater discharge to Waterway, based on information provided by Ecology.

[2] Pre-cleanup groundwater data and data from upgradient wells were excluded from analysis.

[3] No post-cleanup groundwater was available.

[4] Based on average groundwater concentrations, the chemical is not considered to have the potential to impact sediment quality.

Table 2—Determination of Groundwater Screening Concentrations

Chemical	SQO[1] (mg/kg)	Partitioning Coefficient -K_d (L/kg)[2]		GWSC[3] (mg/L)
		Range	Intermediate[4]	
Antimony	150	2-16	10	15.0
Arsenic	57	50-300	76	0.75
Chromium	57	16-360	190	0.30
Copper	390	50-79	79	4.9
Lead	450	230-1,800	1200	0.38
Mercury	0.59	322-5,280	2400	0.0002
Nickel	140	65-700	365	0.38
Zinc	410	100-800	147	2.79
PCP	1.6	100-500	300	0.0053
PCBs	0.3	100-500	300	0.0010

Notes:

[1] SQO from Commencement Bay sediment quality objectives (EPA 1989, 1997).

[2] K_d - Chemical-specific partitioning coefficient, showing range and intermediate value of literature values for specific metal or compound from Strenge and Peterson, 1989.

[3] GWSC groundwater screening concentration determined from relationship where GWSC = SQO/Kd where SQO in mg/kg and Kd based on intermediate Kd.

[4] Intermediate K_d value used in analysis.

APPENDIX A

GROUNDWATER DATA TABLES

Table A-1—Elf Atochem (3009 Taylor Way) Groundwater Chemical Concentrations

Sample ID	Date	Metals (mg/L)			
		Arsenic	Copper	Lead	Zinc
AT-GW-FD-MW-1	1/20/1995	0.025	0.057	0.012	0.070
	7/6/1995	0.028	0.030	0.004	0.070
	11/14/1995	0.039	0.033	0.006	0.035
	2/16/1996	0.042	0.025 U	0.004	0.040
	5/16/1996	0.032	0.025 U	0.001 U	0.02 U
	8/30/1996	0.087	0.025 U	0.007	0.02 U
	2/28/1997	0.030	0.020 U	0.003 U	0.02 U
	6/13/1997	0.061	0.020 U	0.001	0.020 U
	9/16/1997	0.061	0.020 U	0.008	0.057
AT-GW-FD-MW-2	1/20/1995	0.01 U	0.250	0.008	0.050
	7/6/1995	0.01 U	0.025 U	0.009	0.050
	11/14/1995	0.007	0.025 U	0.003 U	0.02 U
	2/16/1996	0.012	0.025 U	0.005	0.030
	5/16/1996	0.015	0.032	0.015	0.060
	8/30/1996	0.021	0.050	0.028	0.110
	2/28/1997	0.02 U	0.020 U	0.003 U	0.020
	6/13/1997	0.013	0.020 U	0.001	0.02 U
	9/16/1997	0.02	0.058	0.029	0.140
AT-GW-FD-MW-3	1/20/1995	0.01 U	0.063	0.003	0.050
	7/6/1995	0.01 U	0.025 U	0.004	0.025
	11/14/1995	0.005 U	0.025 U	0.003	0.02 U
	2/16/1996	0.006	0.025 U	0.002	0.030
	5/16/1996	0.014	0.025 U	0.004	0.030
	8/30/1996	0.014	0.025 U	0.010	0.040
	2/28/1997	0.02 U	0.020 U	0.003 U	0.02 U
	6/13/1997	0.019	0.020 U	0.002	0.020 U
	9/16/1997	0.0063	0.020 U	0.003	0.020 U
AT-GW-FD-MW-4	1/20/1995	0.01 U	0.079	0.007	0.220 U
	7/6/1995	0.01 U	0.031	0.004	0.02 U
	11/14/1995	0.005 U	0.046	0.004	0.059
	2/16/1996	0.006	0.025 U	0.003	0.130
	5/16/1996	0.037	0.025 U	0.001 U	0.02 U
	8/30/1996	0.023	0.025 U	0.017	0.040
	2/28/1997	0.03	0.020 U	0.003 U	0.02 U
	6/13/1997	0.0077	0.020 U	0.001	0.020 U
	9/16/1997	0.017	0.020 U	0.001	0.021
AT-GW-DP-MW-1	1/20/1995	0.022	0.046	0.004	0.030
	7/6/1995	0.028	0.028	0.005	0.02 U
	2/28/1997	0.020 U	0.020 U	0.003 U	0.02 U
	6/13/1997	0.052	0.020 U	0.001 U	0.02 U
	9/16/1997	0.071	0.020 U	0.007	0.033
AT-GW-RS-MW-1	1/20/1995	0.01 U	0.03 U	0.004	0.04
	7/6/1995	0.01 U	0.03 U	0.004	0.02
	5/16/1996	0.001 U	0.03 U	0.001 U	0.02 U
	8/30/1996	0.02 U	0.03 U	0.003 U	0.02 U
	2/28/1997	0.02 U	0.02 U	0.003 U	0.02 U
	6/13/1997	0.001 U	0.02 U	0.001 U	0.02 U
	9/16/1997	0.001 U	0.02 U	0.002	0.02 U

Table A-1—Elf Atochem (3009 Taylor Way) Groundwater Chemical Concentrations

Sample ID	Date	Metals (mg/L)			
		Arsenic	Copper	Lead	Zinc
AT-GW-DP-MW-2	11/14/1995	0.007	0.03 U	0.003 U	0.02 U
	2/16/1996	0.011	0.03 U	0.003	0.03
	5/16/1996	0.015	0.038	0.015	0.08
	8/30/1996	0.02 U	0.04 U	0.021	0.08
AT-GW-RS-MW-2	11/14/1995	0.005 U	0.03 U	0.003 U	0.02 U
	2/16/1996	0.001 U	0.025 U	0.002	0.02
Statistical Summary					
Number		54	54	54	54
Min		0.001 U	0.020 U	0.001 U	0.02 U
Max		0.087	0.250	0.029	0.22
Mean		0.020	0.033	0.006	0.04
Geomean		0.014	0.028651923	0.004	0.03
Median		0.015	0.025	0.003	0.02

Notes:

Values from reports provided by Ecology, not from any report(s) or data submittals reviewed by EPA or WESTON.

Statistical summary of available data by WESTON/EPA. For purposes of the WESTON/EPA analysis, average values are used in subsequent calculations.

U - Constituent not detected at the specified quantitation limit.

mg/L - milligrams per liter

Statistical summary assumes that not detected samples are assigned the specified quantitation limit value.

Table A-2—Elf Atochem (2901 Taylor Way) Groundwater Arsenic Concentrations

AQUIFER	Well ID	Arsenic (mg/L) Sep-97	May-97
UPPER	3A3-1VS	0.4 U	U
	3c1-1BV	0.76	U
	4B1-1BS	0.68	U
	4C1-1	0.4 U	U
	5C3-1TWB	0.4	U
	5C11-1	0.56	0.78
	5C12-1	0.4 U	U
	5D5-1TBS	9.8	9.3
	5D7-1BS	94	66
	5E1-1TBS	22	14
	5E2-1TBS	3.7	1.4
	5E4-1BS	150	97
	5H1-1BS	0.59	U
	6D1-1TS	0.41	0.21
	6D3-1WB	0.82	0.51
	6D9-1S	2.5	2.9
	6D14-1BS	240	150
	6E1-1S	130	230
	6E2-1S	540	600
	6E5-1BS	130	79
	6E6-1BS	6.7	18
	6F2-1TBS	0.98	0.85
	6G1-1TBS	0.4 U	0.27
	7D2-1B	87	110
	7D3-1S	58	16
	7E3-1VS	11	45
	7E8-1VS	17	54
	7E10-1BVS	43	23
	7E12-1BVS	18	11
	7F2-1TBS	1.2	0.75
	8F1-1TVBS	0.4 U	U
	8G1-1TBS	0.79	1
	8G2-1WB	0.49	0.61

Statistical Summary			
Category	All data	Sep-97	May-97
Number	58	33	25
Min	0.21	0.4	0.21
Max	600	540	600
Mean	54	48	61
Geomean	6	5	9
Median	8	3	14

Table A-2—Elf Atochem (2901 Taylor Way) Groundwater Arsenic Concentrations

AQUIFER	Well ID	Arsenic (mg/L) Sep-97	May-97
INTERMEDIATE	3A2-2S	0.4 U	U
	3A5-2VS	0.4 U	U
	5C2-2BS	11	1.3
	5C4-2WB	110	44
	5C5-2	44	22
	5C9-2	34	17
	5C10-2	1.2	7.6
	5D8-2	0.4 U	U
	6D2-2WB	220	28
	6D7-2BS	100	110
	6D10-2BS	170	190
	6D12-2WB	61	62
	6D15-2BS	190	150
	6D22-2	150	14
	6E3-2BS	39	35
	6E9-2BS	830	530
	6F1-2BS	0.44	0.31
	7D1-2BS	73	67
	7E4-2VS	18	--
	7E6-2BVS	21	25
	7E7-2BVS	13	7.7
	7E9-2VS	4.3	3.6
	7E13-2VS	7.1	9
	7E21-2BS	21	22
	8F2-2WB	2	1.7
	8G3-2WB	0.99	1.2
Statistical Summary			
Category	All data	Sep-97	May-97
Number	48	33	29
Min	0.31	0.4	0.21
Max	830	35674	35551
Mean	72	1164	1297
Geomean	16	19	22
Median	22	21	22
DEEP	6D11-3B	0.4 U	0.34

Notes:

Values from reports provided by Ecology, not from any report(s) or data submittals reviewed by EPA or WESTON.

Statistical summary of available data by WESTON/EPA. For purposes of the WESTON/EPA analysis, average values are used in subsequent calculations.

U - Constituent not detected at the specified quantitation limit.

mg/L - milligrams per liter

Statistical summary assumes that not detected samples are assigned the specified quantitation limit value.

"--" not analyzed

Table A-3—Elf Atochem (2901 Taylor Way) Groundwater Metals Concentrations

AQUIFER	Well ID	Dissolved Metals (mg/L) - May 97											
		Sb	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Th	Zn
UPPER	3A3-1VS	U	U	U	U	U	U	U	U	U	U	U	U
	3C1-1BV	U	U	U	U	U	U	U	U	U	U	U	U
	4B1-1BS	U	U	U	0.021	0.096	U	U	U	U	U	U	0.054
	4C1-1	U	U	U	0.022	0.041	U	U	U	U	U	U	0.085
	5C3-1TWB	U	U	U	0.011	0.027	U	U	U	U	U	U	U
	5C11-1	U	U	U	0.043	U	0.16	U	0.046	0.25	U	U	U
	5C12-1	U	U	U	0.011	0.026	0.079	U	U	U	U	U	U
	5D5-1TBS	U	U	U	0.031	0.19	0.08	U	0.044	U	U	U	U
	5D7-1BS	U	U	U	U	0.062	U	0.0027	U	U	U	U	U
	5E1-1TBS	U	U	U	0.89	0.066	0.069	U	U	U	U	U	0.035
	5E2-1TBS	U	U	U	0.024	U	U	U	U	U	U	U	0.037
	5E4-1BS	0.34	U	U	0.014	U	U	U	U	U	U	U	U
	5H1-1BS	U	U	U	U	U	U	U	U	U	U	U	U
	6D1-1TS	U	U	U	U	U	U	U	U	U	U	U	U
	6D3-1WB	U	U	U	U	0.056	U	U	U	U	U	U	U
	6D9-1S	U	U	U	0.011	0.17	U	0.0031	U	U	U	U	U
	6D14-1BS	3.3	U	U	0.042	0.15	0.21	0.018	0.05	U	U	U	U
	6E1-1S	0.91	U	U	U	0.035	U	0.0063	U	U	U	U	U
	6E2-1S	9.2	U	U	0.077	0.1	0.19	0.0021	0.17	U	U	U	U
	6E5-1BS	2.9	U	U	0.036	0.23	0.091	0.015	0.05	U	U	U	0.031
	6E6-1BS	U	U	U	0.016	U	U	U	U	U	U	U	U
	6F2-1TBS	U	U	U	0.017	0.049	U	0.0022	U	U	U	U	0.071
	6G1-1TBS	U	U	U	0.041	0.045	U	U	0.066	U	U	U	0.061
	7D2-1B	4.1	U	U	0.045	0.03	U	0.002	0.07	U	U	U	U
	7D3-1S	1.6	U	U	0.034	0.11	U	0.0052	U	U	U	U	0.057
	7E3-1VS	U	U	U	0.015	U	U	U	U	U	U	U	U
	7E8-1VS	0.6	U	U	0.016	U	U	U	U	U	U	U	U
	7E10-1BVS	0.7	U	U	0.016	0.033	0.076	U	U	0.23	U	U	U
	7E12-1BVS	U	U	U	0.026	U	U	U	U	U	U	U	U
	7F2-1TBS	U	U	U	0.026	U	U	U	0.063	0.22	U	U	U
	8F1-1TVBS	U	U	U	U	0.033	U	U	U	U	U	0.24	U
	8G1-1TBS	U	U	U	0.13	0.12	U	U	0.23	U	U	U	U
	8G2-1WB	U	U	U	0.058	U	U	U	0.073	0.29	U	U	U
Statistical Summary													
Number		9			25	20	8	9	10	4		1	8
Min		0.34	0 U	0 U	0.011	0.026	0.069	0.0020	0.044	0.22	0 U	0.24	0.031
Max		9.2	0 U	0 U	0.89	0.23	0.21	0.0180	0.230	0.29	0 U	0.24	0.085
Mean		2.63	0	0	0.07	0.08	0.12	0.0063	0.086	0.25	0	0.24	0.054
Geomean		1.62	0	0	0.03	0.07	0.11	0.0044	0.073	0.25	0	0.24	0.051
Median		1.6	0	0	0.026	0.059	0.0855	0.0031	0.065	0.24	0	0.24	0.056

Table A-3—Elf Atochem (2901 Taylor Way) Groundwater Metals Concentrations

AQUIFER	Well ID	Dissolved Metals (mg/L) - May 97											
		Sb	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Th	Zn
INTERMEDIATE	3A2-2S	U	U	U	U	U	0.082	U	U	U	0	U	U
	3A5-2VS	U	U	U	U	U	U	U	U	U	U	U	U
	5C2-2BS	U	U	U	0.055	U	0.057	U	0.04	U	U	U	0.051
	5C4-2WB	0.38	U	U	0.081	U	0.086	U	0.041	U	U	0.23	U
	5C5-2	U	U	U	0.14	U	0.081	U	U	U	U	U	0.021
	5C9-2	U	U	U	0.089	U	U	U	U	U	U	U	U
	5C10-2	U	U	U	0.074	U	0.061	U	U	U	U	U	U
	5D8-2	0.31	U	U	U	U	U	U	U	U	U	0.23	U
	6D2-2WB	U	U	U	0.034	U	U	U	U	U	U	U	U
	6D7-2BS	0.44	U	U	0.2	0.19	U	U	U	U	U	U	U
	6D10-2BS	1.1	U	U	0.43	0.15	U	U	0.054	U	U	U	U
	6D12-2WB	0.49	U	U	0.12	0.022	U	U	U	U	U	U	U
	6D15-2BS	0.75	U	U	0.15	0.045	U	U	0.07	U	U	U	U
	6D22-2	U	U	U	0.049	0.04	0.052	U	U	U	U	U	U
	6E3-2BS	0.45	U	U	0.082	0.026	U	U	U	U	U	U	U
	6E9-2BS	13	U	U	0.17	U	0.63	U	0.21	0.51	U	U	0.14
	6F1-2BS	U	U	U	U	U	U	U	U	U	U	U	U
	7D1-2BS	U	U	U	0.074	0.038	U	U	U	U	U	U	U
	7E6-2BVS	U	U	U	0.028	0.026	U	U	U	U	U	U	U
	7E7-2BVS	U	U	U	0.018	0.14	U	U	U	U	U	U	U
	7E9-2VS	U	U	U	0.023	U	0.055	U	U	U	U	U	U
	7E13-2VS	0.49	U	U	0.035	U	U	U	0.044	U	U	U	U
	7E21-2BS	U	U	U	0.049	0.044	U	U	U	U	U	U	U
	8F2-2WB	U	U	U	0.3	0.032	0.094	U	0.26	U	U	U	0.062
	8G3-2WB	U	U	U	0.055	U	0.053	U	U	U	U	U	U
Statistical Summary													
Number		9	0	0	21	11	10	0	7	1	1	2	4
Min		0.31	0 U	0 U	0.018	0.022	0.052	0 U	0.04	0.51	0	0.23	0.021
Max		13	0 U	0 U	0.43	0.19	0.63	0 U	0.26	0.51	0	0.23	0.14
Mean		1.93	0	0	0.11	0.07	0.13	0	0.10	0.51	##	0.23	0.07
Geomean		0.73	0	0	0.08	0.05	0.08	0	0.08	0.51	##	0.23	0.06
Median		0.49	0	0	0.074	0.04	0.071	0	0.054	0.51	0	0.23	0.0565
DEEP	6D11-3B	0.012											

Notes:

Values from reports provided by Ecology, not from any report(s) or data submittals reviewed by EPA or WESTON.

Statistical summary of available data by WESTON/EPA. For purposes of the WESTON/EPA analysis, average values are used in subsequent calculations.

U - Constituent not detected. Quantitation limit not provided.

mg/L - milligrams per liter

Statistical summary does not include constituents which were not detected in the sample.

Table A-4—General Metals Groundwater Concentrations

Well Number	Date	(µg/L)						
		Arsenic	Copper	Lead	Nickel	Zinc	PCBs	PCP
GM-5d	Mar-96	5 U	8	1 U	2 U	17	0.12 U	4.8 U
	Oct-96	5 U	2 U	1 U	2 U	5 U	0.1 U	--
	Mar-97	5 U	1 U	0.4	2 U	2 U	--	--
	Oct-97	5 U	10 U	2 U	20 U	10 U	0.2 U	--
	Mar-98	6	10 U	2 U	20 U	10 U	--	--
	Sep-98	5 U	1 U	2 U	1 U	10 U	0.2 UJ	--
GM-5s	Mar-96	6	3	1 U	9	89	0.096 U	--
	Oct-96	12	2 U	1 U	3	7.6	0.1 U	--
	Mar-97	6	2	0.3	4	4	--	--
	Oct-97	6	10 U	2 U	20 U	27	0.2 U	--
	Mar-98	6	10 U	2 U	20 U	10 U	--	--
	Sep-98	5 U	1 U	2 U	1	10 U	0.2 UJ	--
GM--6d/9d	Mar-96	5 U	2 U	1 U	3	13	0.096 U	5.1 U
	Oct-96	5 U	5.3	1 U	5.3	5.2	0.11 U	--
	Mar-97	5 U	1 U	0.2	5	4	--	--
	Mar-98	5 U	1 U	0.2	5	4	--	--
	Sep-98	5 U	1 U	2 U	6	10 U	0.2 UJ	--
GM-6s/9s	Mar-96	6	2 U	1 U	10	9	0.09 UJ	4.8 U
	Oct-96	9.5	7.3	1 U	8.6	9.5	0.1 U	--
	Mar-97	8	1	0.1 U	9	3	--	--
	Mar-98	8	1	0.1 U	9	3	--	--
	Sep-98	11	1 U	2	7	10 U	1.2 J	--
GM-7d	Apr-96	35	2 U	1 U	7	5 U	0.11 U	0.5 U
	Oct-96	89	2 U	1 U	6.5	5	0.11 U	--
	Mar-97	74	1 U	0.3	9	5	--	--
	Oct-97	68	1 U	2 U	20 U	10 U	0.2 U	--
	Mar-98	66	10 U	2 U	20 U	10 U	--	--
	Sep-98	68	1 U	2 U	13	10 U	0.2 UJ	--
GM-7s	Apr-96	5 U	2 U	1 U	10	5 U	0.11 U	0.5 U
	Oct-96	12	2 U	1 U	13	55	0.29	--
	Mar-97	19	1 U	0.4	14	11	--	--
	Oct-97	24	10 U	2 U	20 U	10 U	0.2 U	--
	Mar-98	26	10 U	2 U	20 U	10 U	--	--
	Sep-98	30	1 U	2 U	11	10 U	0.2 UJ	--
GM-8d	Mar-96	5 U	4	8	3	44	0.1 U	--
	Apr-96	--	--	--	--	--	--	5.2 U
	Oct-96	5 U	2 U	1 U	2.8	5 U	0.11 U	--
	Mar-97	5 U	1 U	0.1	3	3	--	--
	Oct-97	5 U	10 U	2 U	20 U	10 U	0.2 U	--
	Mar-98	5 U	10 U	2 U	20 U	10 U	--	--
	Sep-98	5 U	1 U	2 U	2	10 U	0.2 J	--
GM-8s	Apr-96	--	--	--	--	--	--	5 U
	May-96	25	2	7	54	30	0.095 U	4.9 U
	Oct-96	33	2 U	1 U	82	9	0.13 U	--
	Mar-97	22	1 U	0.4	69	6	--	--
	Oct-97	30	10 U	2 U	70	10 U	0.2 U	--
	Mar-98	21	10 U	2 U	52	10 U	--	--
	Sep-98	36	1 U	2 U	59	10 U	0.2 UJ	--
Statistical Summary								
Number		46	46	46	46	46	30	8
Min		5 U	1 U	0.1 U	1 U	2 U	0.09 U	0.5 U
Max		89	10	8	82	89	1.2	5.2 U
Average		18.53	3.90	1.55	16.79	12.51	0.19	3.85
Geomean		11.19	2.48	1.06	9.30	8.88	0.16	2.80
Median		6	2	1	9	10	0.165	4.85

Notes:

Values provided came from an Ecology data summary, not from any report(s) or data submittals reviewed by EPA or WESTON.

Statistical summary of available data by WESTON/EPA. For purposes of the WESTON/EPA analysis, average values are used in subsequent calculations.

U - Constituent not detected at the specified quantitation limit.

J - estimated value

µg/L - micrograms per liter

Statistical summary assumes that not detected samples are assigned the specified quantitation limit value.

"--" - not analyzed

Table A-5—General Metals Seep Concentrations

Sample No	Sample Date	Dissolved Metals (mg/L)		
		Arsenic	Copper	Zinc
Seep #1	3/25/1997	0.042	0.129	0.254
Seep #1d	3/25/1997	0.042	0.13	0.254
Seep #1	4/24/1998	0.026	0.121	0.441
Seep #2	4/24/1998	0.023	0.106	0.437
Statistical Summary				
Number		4	4	4
Min		0.023	0.106	0.254
Max		0.042	0.130	0.441
Average		0.033	0.122	0.347
Geomean		0.032	0.121	0.334
Median		0.034	0.125	0.346

Notes:

Values provided came from an Ecology data summary, not from any report(s) or data submittals reviewed by EPA or WESTON.

Statistical summary of available data by WESTON/EPA. For purposes of the WESTON/EPA analysis, average values are used in subsequent calculations.

U - Constituent not detected at the specified quantitation limit.

mg/L - milligrams per liter

Statistical summary assumes that not detected samples are assigned the specified quantitation limit value.

*Seep #1d and Seep #2 are both duplicates of Seep #1 on their respective dates.

Table A-6—Wasser Winters Groundwater Chemical Concentrations

Well	Sample Date	Metals (mg/L)			
		Arsenic	Copper	Lead	Zinc
CMW-1	2/7/1994	0.002	0.005	0.004	0.045
	5/17/1994	0.002	0.002 U	0.004	0.006
	8/17/1994	0.004	0.002 U	0.003	0.005
	11/11/1994	0.003	0.002 U	0.001	0.008
	5/17/1995	0.006	0.002 U	0.001 U	0.004 U
	9/29/1995	0.005 U	0.002 U	0.001	0.004 U
	3/6/1996	0.005	0.002 U	0.001	0.004 U
	10/8/1996	0.001 U	0.002 U	0.001	0.004 U
	8/14/1997	0.002	0.002 U	0.001 U	0.004 U
	12/30/1997	0.004	0.002 U	0.001 U	0.133
	6/11/1998	0.001 U	0.002 U	0.002 U	0.004 U
	12/22/1998	0.001 U	0.002 U	0.005 U	0.004 U
CMW-1 (dup)	5/17/1995	0.005	0.002 U	0.001 U	0.004 U
CMW-2	2/7/1994	0.001 U	0.007	0.002	0.005
	5/17/1994	0.001 U	0.007	0.002	0.016
	8/17/1994	0.002	0.002 U	0.004	0.017
	11/11/1994	0.007	0.003	0.004	0.01
	5/17/1995	0.003	0.002 U	0.004	0.017
	9/29/1995	0.023	0.002 U	0.001 U	0.004 U
	3/6/1996	0.01	0.002 U	0.001	0.004 U
	10/8/1996	0.012	0.002 U	0.001 U	0.004 U
	8/14/1997	0.018	0.002 U	0.001 U	0.004
	12/30/1997	0.01	0.002 U	0.001 U	0.092
	6/11/1998	0.008	0.002 U	0.001 U	0.004
	12/22/1998	0.008	0.002 U	0.001 U	0.004
CMW-2 (dup)	2/7/1994	0.001	0.012	0.001	0.008
	12/30/1997	0.011	0.002 U	0.001	0.016
CMW-3	2/7/1994	0.049	0.002 U	0.001 U	0.008
	5/17/1994	0.0072	0.002 U	0.001	0.007
	8/17/1994	0.095	0.002 U	0.001 U	0.005
	11/11/1994	0.082	0.002 U	0.002	0.008
	5/17/1995	0.074	0.002 U	0.001 U	0.007
	9/29/1995	0.1	0.002 U	0.001 U	0.005
	3/6/1996	0.082	0.002 U	0.001 U	0.004 U
	10/8/1996	0.083	0.002 U	0.001 U	0.004 U
	8/14/1997	0.114	0.002 U	0.001 U	0.005
	12/30/1997	0.123	0.002 U	0.001 U	0.139
	6/11/1998	0.089	0.002 U	0.001 U	0.004 U
	12/22/1998	0.19	0.002 U	0.001 U	0.004 U
CMW-3 (dup)	5/17/1994	0.074	0.002 U	0.002	0.005
	8/17/1994	0.086	0.002 U	0.002	0.008
	11/11/1994	0.025	0.002 U	0.002	0.004 U
	9/29/1995	0.102	0.002 U	0.001 U	0.004 U
	10/8/1996	0.084	0.002 U	0.001 U	0.004 U
	8/14/1997	0.135	0.002 U	0.001 U	0.007
	6/11/1998	0.086	0.002 U	0.001 U	0.004 U
	12/22/1998	0.17	0.002 U	0.001 U	0.004 U

Table A-6—Wasser Winters Groundwater Chemical Concentrations

Well	Sample Date	Metals (mg/L)			
		Arsenic	Copper	Lead	Zinc
CMW-4	2/7/1994	0.006	0.003	0.002	0.013
	5/17/1994	0.023	0.002 U	0.003	0.008
	8/17/1994	0.033	0.002 U	0.002	0.006
	11/11/1994	0.026	0.003	0.014	0.01
	5/17/1995	0.024	0.002 U	0.001 U	0.004 U
	9/29/1995	0.034	0.002 U	0.001 U	0.006
	3/6/1996	0.018	0.002 U	0.001 U	0.004 U
	10/8/1996	0.026	0.002 U	0.001 U	0.004 U
	8/14/1997	0.027	0.002 U	0.001 U	0.004 U
	12/30/1997	0.021	0.002 U	0.001 U	0.146
	6/11/1998	0.022	0.002 U	0.001 U	0.004
	12/22/1998	0.028	0.002 U	0.001 U	0.009
CMW-4 (dup)	3/6/1996	0.018	0.002 U	0.001 U	0.004 U
Statistical Summary					
Number		60	60	60	60
Min		0.001 U	0.002 U	0.001 U	0.004 U
Max		0.1900	0.0120	0.0140	0.1460
Mean		0.0385	0.0024	0.0018	0.0149
Geomean		0.0153	0.0022	0.0014	0.0071
Median		0.0195	0.0020	0.0010	0.0050

Notes:

Values from reports provided by Ecology, not from any report(s) or data submittals reviewed by EPA or WESTON.

Statistical summary of available data by WESTON/EPA. For purposes of the WESTON/EPA analysis, average values are used in subsequent calculations.

U - Constituent not detected at the specified quantitation limit.

mg/L - milligrams per liter

Statistical summary assumes that not detected samples are assigned the specified quantitation limit value.

Table A-7—Louisiana-Pacific Groundwater Chemical Concentrations

Well Number	Date Sampled	Metals (mg/L)			
		Arsenic	Copper	Lead	Zinc
LP-1	3/22/1995	0.01 U	0.003	0.003 U	0.02 U
	6/21/1995	0.0046	0.0019	0.001 U	0.003
	9/25/1995	0.005 U	0.0014	0.003 U	0.02 U
	12/28/1995	0.005 U	0.01 U	0.003 U	0.05
	4/19/1996	0.005 U	0.003	0.003 U	0.01 U
	6/27/1996	0.01 U	0.002 U	0.008 U	0.01 U
	11/25/1996	0.005 U	0.002 U	0.002 U	0.005 U
	12/17/1996	0.02 U	0.02 U	0.05 U	0.02 U
	3/28/1997	0.01 U	0.002 U	0.008 U	0.08 U
	7/9/1997	0.001 U	0.001 U	0.0005 U	0.0094
	9/26/1997	0.0027	0.001 U	0.0005 U	0.0043
	12/18/1997	0.0033	0.0018	0.0005 U	0.0056
	6/30/1998	0.0042	0.001 U	0.0005 U	0.002 U
LP-2	3/22/1995	0.01 U	0.002 U	0.003 U	0.02 U
	6/21/1995	0.0046	0.0013	0.001 U	0.0058
	9/25/1995	0.005 U	0.043	0.0058 U	0.02 U
	12/28/1995	0.005 U	0.01 U	0.003 U	0.02 U
	3/28/1996	0.01 U	0.002 U	0.008 U	0.02 U
	6/27/1996	0.01 U	0.002 U	0.008 U	0.01 U
	11/25/1996	0.005 U	0.002 U	0.002 U	0.005 U
	12/17/1996	0.2 U	0.02 U	0.05 U	0.02 U
	7/9/1997	0.001 U	0.001 U	0.00074	0.018
	9/26/1997	0.0037	0.001 U	0.0005 U	0.003
	12/18/1997	0.0015	0.002	0.0005 U	0.0028
	6/30/1998	0.0042	0.0013	0.0005 U	0.002 U
LP-4	3/22/1995	0.01 U	0.005	0.003 U	0.02 U
	6/21/1995	0.0069	0.0059	0.001 U	0.018
	9/25/1995	0.0071	0.022	0.0046	0.02 U
	12/28/1995	0.002 U	0.005	0.001 U	0.02 U
	3/28/1996	0.01 U	0.002 U	0.008 U	0.02 U
	6/27/1996	0.01 U	0.004	0.008 U	0.01 U
	11/25/1996	0.005 U	0.004	0.004	0.007
	12/17/1996	0.2 U	0.02 U	0.05 U	0.02 U
	3/28/1997	0.01 U	0.004	0.008 U	0.08 U
	7/9/1997	0.0029	0.0017	0.00055	0.027
	9/26/1997	0.0076	0.002	0.0005 U	0.0066 U
	12/18/1997	0.0073	0.0062	0.0005 U	0.01
	6/30/1998	0.0033	0.0025	0.0005 U	0.002 U

Table A-7—Louisiana-Pacific Groundwater Chemical Concentrations

Well Number	Date Sampled	Metals (mg/L)			
		Arsenic	Copper	Lead	Zinc
LP-5	3/22/1995	0.1 U	0.002	0.003 U	0.02 U
	6/21/1995	0.0031	0.0034	0.001 U	0.0033
	9/25/1995	0.0056	0.02	0.0044	0.02 U
	12/28/1995	0.005 U	0.002 U	0.001 U	0.02 U
	3/28/1996	0.01 U	0.002 U	0.008 U	0.02 U
	6/27/1996	0.01 U	0.002 U	0.008 U	0.01 U
	11/25/1996	0.005 U	0.002 U	0.002 U	0.016
	12/17/1996	0.2 U	0.02 U	0.05 U	0.02 U
	3/28/1997	0.01 U	0.002 U	0.008 U	0.08 U
	7/9/1997	0.001 U	0.001 U	0.001	0.037
	9/26/1997	0.0077	0.001 U	0.0005 U	0.01
	12/18/1997	0.004	0.0017	0.0005 U	0.0061
	6/30/1998	0.011	0.001 U	0.0005 U	0.0031
Statistical Summary					
Count		51	51	51	51
Min		0.001 U	0.001 U	0.0005 U	0.002 U
Max		0.2	0.043	0.05	0.08
Mean		0.01961	0.00553	0.006737	0.017882
Geomean		0.00695	0.003	0.002349	0.011883
Median		0.005	0.002	0.003	0.018

Notes:

Values from reports provided by Ecology, not from any report(s) or data submittals reviewed by EPA or WESTON.

Statistical summary of available data by WESTON/EPA. For purposes of the WESTON/EPA analysis, average values are used in subsequent calculations.

U - Constituent not detected at the specified quantitation limit.

mg/L - milligrams per liter

Statistical summary assumes that not detected samples are assigned the specified quantitation limit value.

Table A-8—Blair Backup Groundwater Chemical Concentrations

Sample Location	Date	Dissolved Metals (µg/L)				
		Arsenic	Copper	Lead	Nickel	Zinc
HC-4S	Apr-94	11	31	8	34	18 U
	Oct-94	190	10 U	4 J	4 J	7
	Apr-95	5 U	9	3 U	12	3 U
	Oct-95	170	42	13	28	15 U
	Apr-96	150	30	4	36	23 U
	Oct-96	180	8 J	3 J	5 J	9 J
HC88S	Apr-94	13	33	6	35	16 U
	Oct-94	180	16 J	5 J	7 J	11
HC-11SR	Apr-94	15	1 U	1 U	7	5 U
	Oct-94	260	1 U	3	2 UJ	5 U
	Apr-95	110	1 U	1 U	5 U	6 U
	Oct-95	210	1 U	1 U	5 U	9 U
	Apr-96	140	2 U	1 U	4 U	9
	Oct-96	300	1 U	1 U	2 U	8 B
HC-88	Oct-95	220	1 U	2 U	5 U	8 U
HC-26S	Apr-94	21	1 U	1	5 U	5 U
	Oct-94	130	26 J	6 J	5 J	12
	Apr-95	34	1 U	1 U	5 U	3 U
	Oct-95	110	40	24	5	26
	Apr-96	29	2 U	1 U	5	10
	Oct-96	320	3	1 U	2 U	5 U
HC-33S	Oct-96	180	7	2	3	5 U
EPA-9SR	Apr-94	51	14	14	12	12 U
	Oct-94	47	19 J	20 J	3 J	12
	Apr-95	22	8	19 B	8	4 U
	Oct-95	33	47	18	25	20
	Oct-96	60	7 J	9 J	5 U	14 J
Statistical Summary						
Number		27	27	27	27	27
Min		5 U	1 U	1 U	2 U	3 U
Max		320	47	24	36	26
Average		118.2	13.4	6.4	10.1	10.4
Geomean		72.5	6.0	3.5	6.7	8.8
Median		110	8	3	5	9

Notes:

Values for reports provided by Ecology, not from any report(s) or data submittals reviewed by EPA or WESTON

Statistical summary of available data by WESTON/EPA. For purposes of the WESTON/EPA analysis, average values are used in subsequent calculations.

U - Constituent not detected at the specified quantitation limit.

J - "estimated value"

B - detected in blank

µg/L - milligrams per liter

Statistical summary assumes that not detected samples are assigned the specified quantitation limit value.

Table A-9—USG Interiors Groundwater Metals Concentrations

Well No	Aquifer	Sample Date	Metals (mg/L)											
			Antimony		Arsenic		Chromium		Copper		Lead		Zinc	
			total	dissolved	total	dissolved	total	dissolved	total	dissolved	total	dissolved	total	dissolved
MW4	Surface Aquifer	23-Oct-98	0.05 U	0.05 U	0.0077	0.0077	0.01 U	0.01 U	0.01 U	0.01 U	0.0014	0.0011 U	0.01 U	0.01 U
MW5		23-Oct-98	0.05 U	0.05 U	0.003 U	0.003 U	0.057	0.057	0.016	0.01 U	0.0046	0.0027	0.01 U	0.01 U
MW6		23-Oct-98	0.05 U	0.05 U	0.003 U	0.003 U	0.012	0.01 U	0.01 U	0.01 U	0.0046	0.0011 U	0.01 U	0.01 U
MW8	2nd Aquifer	23-Oct-98	0.05 U	0.05 U	0.005 U	0.005 U	0.01 U	0.01 U	0.01 U	0.01 U	0.0098	0.0011 U	0.01 U	0.01 U
Seep 1		28-Apr-98	0.05 U	0.05 U	0.015	0.013	0.01 U	0.01 U	0.01 U	0.01 U	0.003 U	0.003 U	0.023	0.041
		19-Apr-99	0.1 U	0.1 U	0.074	0.087	0.02 U	0.02 U	0.02 U	0.02 U	0.003 U	0.003 U	0.02 U	0.02 U
Seep 2		28-Apr-98	0.2	0.18	0.027	0.018	0.01 U	0.01 U	0.031	0.01 U	0.0061	0.003 U	0.13	0.12
		19-Apr-99	0.25 U	0.25 U	0.088	0.09	0.05 U	0.05 U	0.05 U	0.05 U	0.0046	0.003 U	0.05 U	0.05 U
Statistical Summary														
Number			8	8	8	8	8	8	8	8	8	8	8	8
Min			0.05 U	0.05 U	0.003 U	0.003 U	0.01 U	0.01 U	0.01 U	0.01 U	0.0014	0.0011 U	0.01 U	0.01 U
Max			0.25 U	0.25 U	0.088	0.09	0.057	0.057	0.05	0.05 U	0.0098	0.003	0.13	0.12
Ave			0.1	0.098	0.0278	0.0283	0.022	0.02	0.02	0.02 U	0.005	0.002	0.03	0.03
Geomean			0.079	0.078	0.0132	0.0126	0.017	0.02	0.02	0.01 U	0.004	0.002	0.02	0.02
Median			0.05	0.05	0.0114	0.0104	0.011	0.01	0.013	0.01 U	0.005	0.003	0.015	0.015

Notes:

Values provided came from an Ecology data summary, not from any report(s) or data submittals reviewed by EPA or WESTON.

Statistical summary of available data by WESTON/EPA. For purposes of the WESTON/EPA analysis, average total concentrations are used in subsequent calculations.

Total - unfiltered sample; dissolved - filtered sample

U - Constituent not detected at the specified quantitation limit.

mg/L - milligrams per liter

Statistical summary assumes that not detected samples are assigned the specified quantitation limit value.

Table A-10—Murray Pacific Groundwater Chemical Data

Well #	Sample Date	Arsenic (mg/L)	Copper (mg/L)	Lead (mg/L)	Zinc (mg/L)
MW-16 (D)	1/15/1997	0.02	0.02 U	0.02 U	0.02 U
	7/23/1997	0.0012	0.0036	0.0011	0.0079
	2/3/1998	0.001 U	0.001 U	0.0005 U	0.02 U
	7/17/1998	0.024	0.001 U	0.0005 U	0.02 U
MW-17 (S)	1/15/1997	0.28	0.16	0.22	0.25
	7/23/1997	1.1	0.01	0.025	0.013
	2/3/1998	0.75	0.0024	0.0051	0.0051
	7/17/1998	0.97	0.0014	0.0019	0.0022
MW-18 (D)	1/15/1997	0.02 U	0.02 U	0.02 U	0.02 U
	7/23/1997	0.0015 U	0.0023	0.0005 U	0.0027
	2/3/1998	0.001 U	0.0011	0.0005 U	0.002 U
	7/17/1998	0.0071	0.001 U	0.0005 U	0.002 U
MW-19 (S)	1/15/1997	0.065	0.02 U	0.02 U	0.02 U
	7/23/1997	0.15	0.0058	0.00057	0.0041
	2/3/1998	0.17	0.0028	0.0005 U	0.002 U
	7/17/1998	0.28	0.0055	0.0005 U	0.002 U
MW-20 (S)	1/15/1997	0.02 U	0.048	0.02 U	0.34
	7/23/1997	0.024	0.011	0.0013	0.024
	2/3/1998	0.092	0.0013	0.0005 U	0.0094
	7/17/1998	0.04	0.015	0.0023	0.022
MW-21 (D)	1/15/1997	0.02 U	0.02 U	0.02 U	0.02 U
	7/23/1997	0.001 U	0.0023	0.0005 U	0.0033
	2/3/1998	0.001 U	0.0037	0.0005 U	0.002 U
	7/17/1998	0.065	0.0028	0.0005 U	0.002 U
Statistical Summary					
Number		24	24	24	24
Min		0.001 U	0.001 U	0.0005 U	0.002 U
Max		1.1	0.16	0.22	0.34
Average		0.171	0.015	0.015	0.034
Geomean		0.027	0.005	0.002	0.009
Median		0.024	0.004	0.001	0.009

Notes:

Values provided came from an Ecology data summary, not from any report(s) or data submittals reviewed by EPA or WESTON.

Statistical summary of available data by WESTON/EPA. For purposes of the WESTON/EPA analysis, average values are used in subsequent calculations.

U - Constituent not detected at the specified quantitation limit.

mg/L - milligram per liter

Statistical summary assumes that not detected samples are assigned the specified quantitation limit value.